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# (54) Pipe bending apparatus

(57) A pipe-bending apparatus 1 comprises a pivotable bend arm 2, upper and lower bend dies 3 (and 4 not shown) mounted on the arm 2 on a common vertical axis, clamping means 5, 6, also mounted on the arm for clamping a pipe P in the respective die, and follower slides 8 and 9 of channel-shaped configuration respectively associated with the dies 3 and 4 for engagement with the pipe. The slides 8 and 9 may be advanced independently of each other so that, during bending at the larger radius die 3, slide 9 need not be advanced thereby avoiding any possibility of interference with clamp 6.

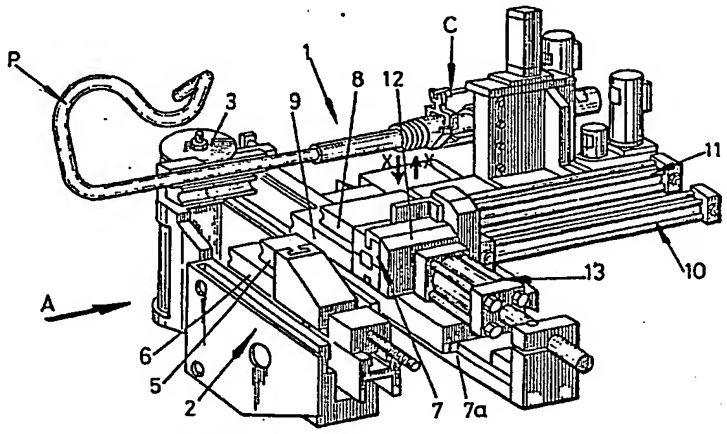


FIG. 1

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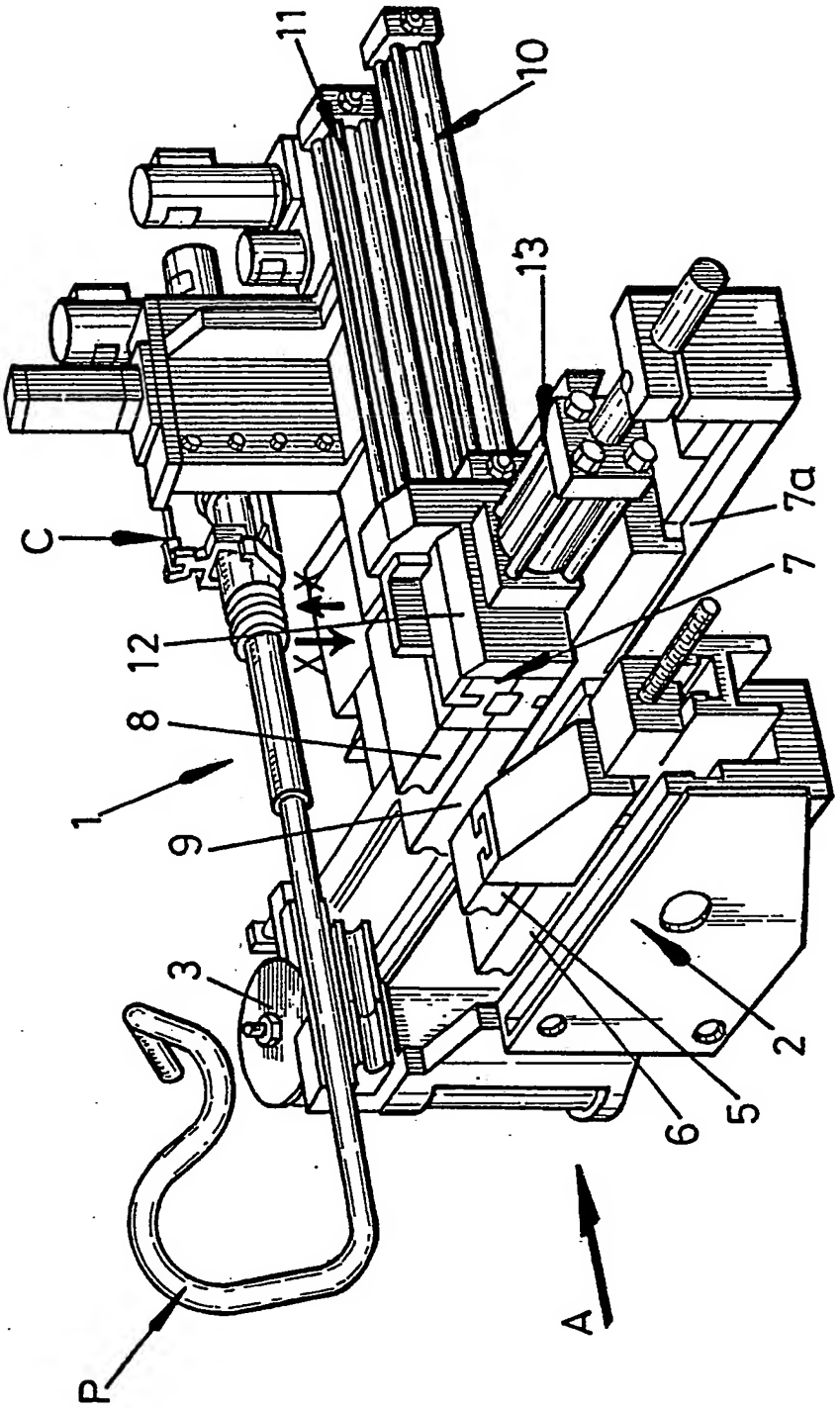


FIG.1

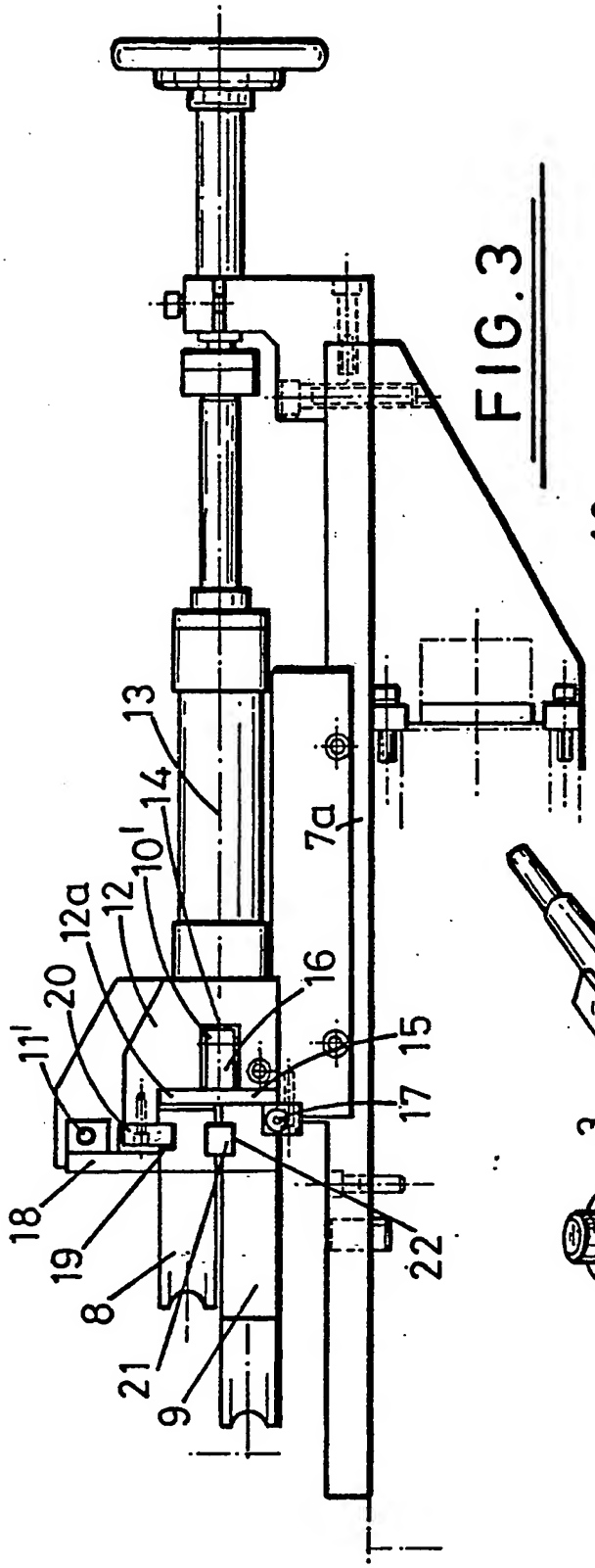


FIG. 3

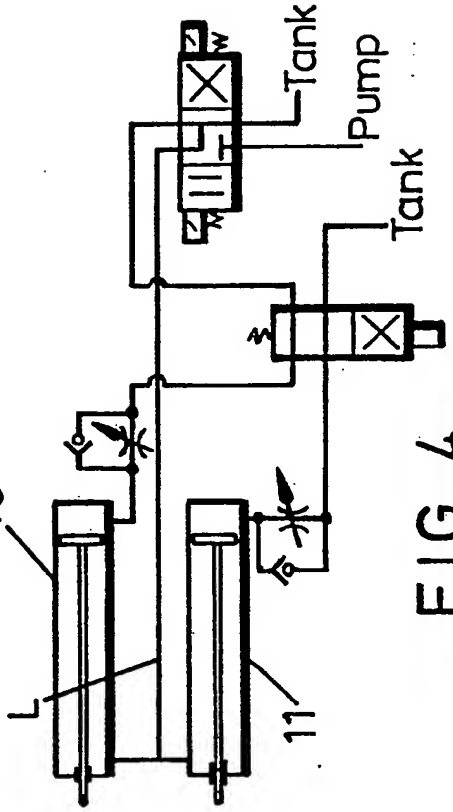


FIG. 4

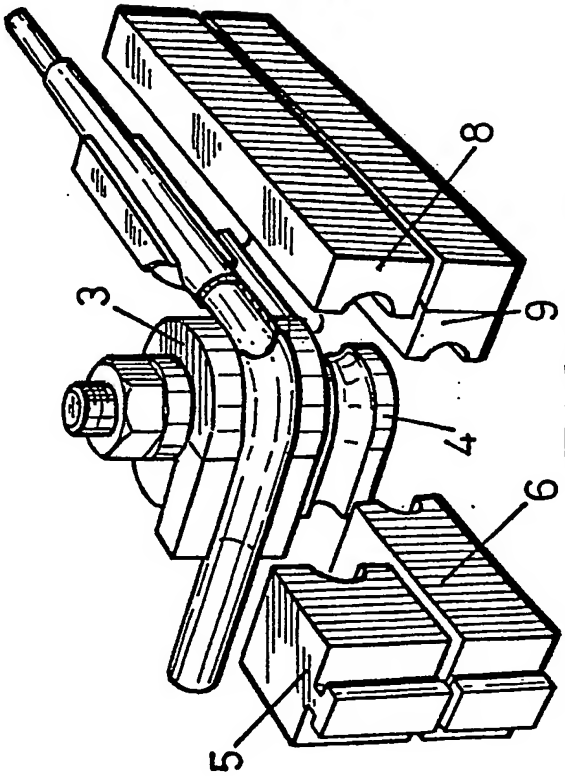


FIG. 2

SPECIFICATION

**Pipe bending apparatus**

The present invention relates to apparatus for the bending of metal tubes and other elongate stock, i.e. so-called pipe-bending apparatus.

Apparatus for the draw bending of pipes, tubes and the like is well known. Generally, such apparatus comprises a carriage or the like for advancing the pipe along the centre line of the apparatus, a pivotal bend arm, a bend die and a pipe clamp both mounted on the bend arm, and a follower slide. To effect bending, the pipe is firstly advanced by the carriage so that the portion of the pipe to be bent is in the region of the bend die, and advancement of the carriage is terminated. At this stage, the bend arm extends transversely to the follower slide. The clamp is moved along the bend arm to clamp the pipe in the die, and the follower slide is applied against the pipe. Bending now commences by pivotally moving the bend arm so as to rotate the bend die. During this pivotal movement of the bend arm, the pipe clamp is moved therewith. Simultaneously, the follower slide is moved tangentially to the bend die and the bend is produced. During this bending, the pipe (and thus the carriage) is "pulled" along the centre line of the apparatus.

Such apparatus may be of the 'shift-head' type which incorporates a plurality (usually two) of bend dies (usually of different radii) positioned one above the other on the same vertical axis. In a shift-head machine, the pipe to be bent is positioned along either an upper or lower centre line (the two centre lines being in the same vertical plane) depending on which of the dies is to be used. The term 'shift-head' is derived from the fact that the dies of the apparatus may be moved (or shifted) laterally of the machine centre line so that the required die engages the pipe on the centre-line of the machine.

The 'shift-head' apparatus has upper and lower clamps each mounted on the bend arm and each serving to clamp the pipe in one of the bend dies. Similarly, the follower slide of the apparatus comprises a plurality of channeled blocks or the like (one of each of the bend dies) mounted on a common slide so that both blocks are advanced at the same speed during bending (irrespective of which die is used).

We have however found that problems arise in the case where the dies are used for producing bends of significantly different radii.

When bending is effected at the larger radius die, the channeled block associated with the smaller radius die may interfere with the pipe clamp associated with the smaller radius die. The problem arises because the channeled block for the smaller die necessarily projects laterally beyond that for the larger radius die by a significant distance and, similarly, the pipe clamp for the smaller radius die projects laterally beyond that for the larger radius die. When bending is effected at the larger radius die, the follower slide arrangement must be advanced more quickly than when bending is effected at the lower radius die, whereas the angular speed of the bend arm is similar (or the same) in both cases. As a result, the channeled block for the smaller radius die is advanced relatively quickly towards the clamp for the smaller radius die and may ultimately make contact therewith, which is obviously undesirable.

It is an object of the present invention to obviate or mitigate this disadvantage.

According to the present invention there is provided pipe-bending apparatus comprising a bend arm, upper and lower bend dies mounted on the arm on a common vertical axis, clamping means for clamping a pipe in the dies, and a follower slide associated with each of the dies wherein the slides may be advanced independently of each other.

The invention is particularly applicable to a shift-head bending machine with a plurality (e.g. 2) of dies of significantly different bend radii in which the pipe clamp for the smaller radius die projects laterally beyond that for the larger radius die, and the follower slide for the smaller radius die projects laterally beyond that for the larger radius die.

During bending at the larger radius die, the follower slide associated with the smaller radius die need not be advanced, thereby avoiding any possibility of interference with the pipe clamp for the smaller radius die.

The invention will be further described by way of example only with reference to the accompanying drawings, in which:

*Figure 1* is a perspective view of one embodiment of pipe-bending apparatus in accordance with the invention;

*Figure 2* is a detail of the bend die arrangement of the apparatus of Figure 1;

*Figure 3* is a detail of the follower slide arrangement of the apparatus of Figure 1 as viewed in the direction of arrow A; and

*Figure 4* is a diagram of a hydraulic control circuit.

The apparatus 1 illustrated in Figure 1 is a so-called shift-head bending machine. The apparatus comprises a pivotal bend arm 2 on which are mounted (on a common-vertical axis) upper and lower bend dies 3 and 4 of different radii (see Figure 2 - die 3 being of a larger bend radius than die 4), upper and lower clamps 5 and 6 (mounted on the arm 2), and a follower slide arrangement 7 to be described in more detail below.

As is well known for shift-head bending machines, bending is effected along either an upper centre line (as illustrated in Figure 1 for the larger radius die 3) or along a lower centre line (for the die 4), the upper and lower centre lines being in the same vertical plane. To cater for bending along vertically spaced centre-lines the pipe P may be moved vertically (arrows X). Provision for this movement is provided in carriage C which is used for positioning the pipe for the bending operation. The term shift-head derives from the fact that, to change from bending at one die to the other, the head of the machine (i.e. that part incorporating the dies 3 and 4) is laterally shifted so that as the pipe is changed from one centre line to the other it is engaged by the appropriate die.

The follower slide arrangement incorporates upper and lower channeled blocks 8 and 9 which are associated with the upper and lower dies 3 and 4

respectively. To cater for the fact that lower die 4 is of smaller radius than upper die 3, the block 9 projects laterally beyond block 8. Similarly, pipe clamp 6 (for the smaller radius die 4) projects beyond clamp 5.

Referring back now to Figure 1, the pipe P is shown as located in the larger radius die 3 and the bend arm 2 is in the 'start' position for a bending operation, although the clamp 5 and channeled block 8 have not yet been engaged with the pipe. It will be seen that if (as in the prior art apparatus) the channeled blocks 8 and 9 can only be advanced as a single unit, there is the possibility that block 9 may interfere with clamp 6 (assuming that the linear advancement of blocks 8 and 9 is greater than the 'angular' speed of clamp 6 - as is likely to be the case for bending at the larger radius die).

To avoid this problem, and in accordance with the invention, the blocks 8 and 9 provide independently movable follower slides for the apparatus. Movement of slide 9 is effected by a fluid pressure (e.g. hydraulic) cylinder 10 whereas movement of slide 8 is effected by a further fluid pressure operated cylinder 11.

Consequently, during bending at the larger radius die 3, slide 9 need not be advanced thereby avoiding any possibility of interference with clamp 6.

Figure 3 shows a detail of the follower slide arrangement 7. Cylinders 10 and 11 (which are hidden in Figure 3) are mounted on a support head 12 which is itself moveable laterally of the machine centre line (along a slideway 7a) by a further cylinder 13 so as to allow the slides 8 and 9 to be moved towards and away from the dies 3 and 4. Although cylinders 10 and 11 are hidden in Figure 3, their rods are illustrated therein as 10' and 11' respectively.

Support 12 incorporates a central channel 14 extending parallel to the machine centre line. Slide 9 is mounted on a plate 15 which is moveable along a face 12a support head and which is attached to a bracket 16 which locates in channel 14. Bracket 16 is, in turn, attached to the rod 10' of cylinder 10. Thus extension or retraction of cylinder 10 effects corresponding linear movement of bracket 16, plate 15 and thus slide 9. A small block 17 (over which slide 9 is moveable) serves as a guide for the movement of plate 15.

A further bracket 18 is attached to the rod 11' of cylinder 11 and is fast with the follower slide 8. Thus, extension and retraction of cylinder 11 causes movement of slide 8 relative to slide 9. Slide 8 has an upper guide recess 19 in which locates a guide element 20 fixed on support head 12. Additionally, affixed to the base of follower slide 8 is a guide bar 21 which slides in a channel 22 in the upper surface of follower slide 9.

As mentioned above, follower slides 8 and 9 are independently movable and, additionally, the accurate linear movement required of theses slides is ensured by the guide components described above.

The operation of cylinders 10 and 11 may be governed by conventional hydraulic control valves and a suitable arrangement is illustrated in Figure 4.

Figure 4 is self explanatory and no further explanation will be given save to say that, upon extension of either cylinder 10 or 11, hydraulic fluid passes from that cylinder to a line L which is common to both cylinders. Thus, during extension of, say, cylinder 10 to move slide 9, a back pressure is established in cylinder 11 thus ensuring that the follower slide 8 remains stationary is not subject to unwanted movement with slide 9.

Although the invention has been illustrated with specific reference to dies 3 and 4 of different radii, the use of independently moveable follower slides is equally applicable in the case of dies with the same radii as such an arrangement may be required for certain bending operations.

## CLAIMS

1. Pipe-bending apparatus comprising a bend arm, upper and lower bend dies mounted on the arm on a common vertical axis, clamping means for clamping a pipe in the dies, and a follower slide associated with each of the dies wherein the slides may be advanced independently of each other.

2. Apparatus as claimed in claim 1, which is a shift head bending apparatus having a plurality of dies of different bend radii, said apparatus having pipe clamps for each of the dies with the clamp for the smaller radius die projecting beyond that for the larger radius die, and the follower slide for the smaller radius die projecting laterally beyond that for the larger radius die.

3. Apparatus as claimed in claim 2, wherein the larger bend radius die is the upper die.

4. Apparatus as claimed in any one of claims 1 to 3, wherein each follower slide is associated with a respective fluid pressure operated cylinder for effecting said independent linear movement.

5. Apparatus as claimed in claim 4, wherein said fluid pressure operated cylinders are operated by a fluid pressure supply arrangement adapted to generate a back pressure in one of said cylinders when the other cylinder is being extended to advance the associated follower slide.

6. Apparatus as claimed in claim 4 or 5, wherein the cylinders and the follower slides are mounted on a support unit which is movable laterally of the centre line of the apparatus.

7. Apparatus as claimed in claim 6, wherein the support unit has a channel extending parallel to the centre line of the apparatus and a first one of said follower slides is connected to its associated cylinder by means which move along said channel during extension and retraction of this cylinder.

8. Apparatus as claimed in claim 7, wherein said first follower slide is guided in its linear movement by a guide element over which the slide moves and which is fixed relative to the support unit.

9. Apparatus as claimed in claim 7 or 8, wherein the other of said slides has a guide bar which is slidable in a channel provided in the first said slide.

10. Pipe bending apparatus substantially as hereinbefore described with reference to the accompanying drawings.

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